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Patent Abstracts of Japan

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APPLICANT : SEIKO EPSON CORP;

INVENTOR : ARAKAWA KATSUHARU;

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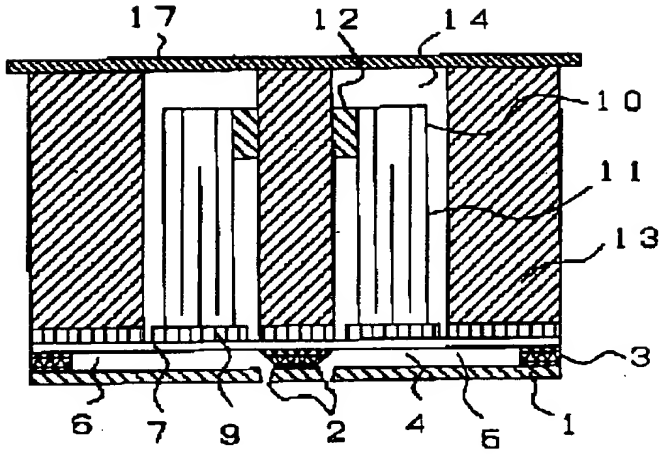
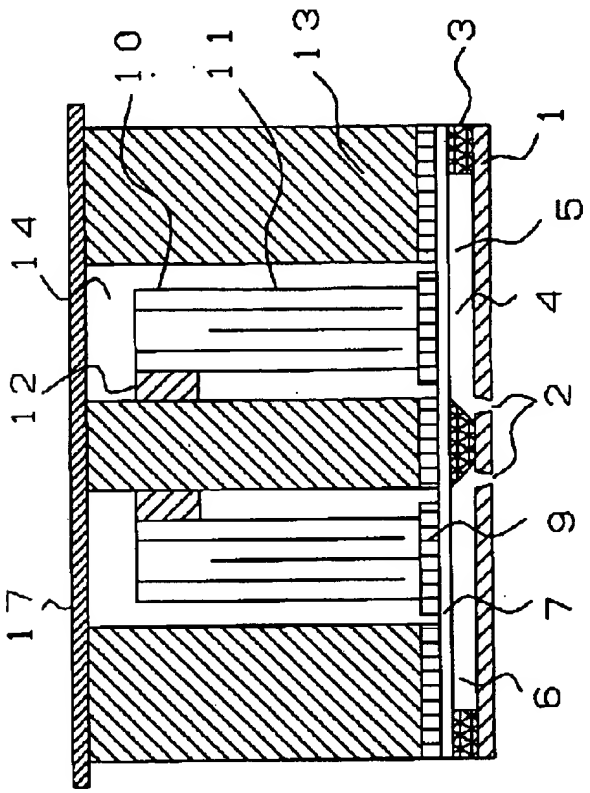
TITLE : INK-JET HEAD AND PRODUCTION METHOD THEREOF



ABSTRACT : PROBLEM TO BE SOLVED: To provide an ink-jet head with high size accuracy and positioning accuracy, and a production method thereof.

SOLUTION: A highly oriented film to be a vibrating plate 7 is adhered on a spacer 3. An island part 9 is formed thereon with a photosensitive resin film. The island part 9 elongates in the longitudinal direction of a pressure generating room 4 for efficiently transmitting dislocation of a piezoelectric oscillator 11. By accordingly forming the island part 9 of a photosensitive resin film integrally with the spacer 3 and the vibrating plate 7, an ink-jet head with little printing quality irregularity can be produced with a high yield.

Drawing selection [Representative drawing]



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PATENT ABSTRACTS OF JAPAN

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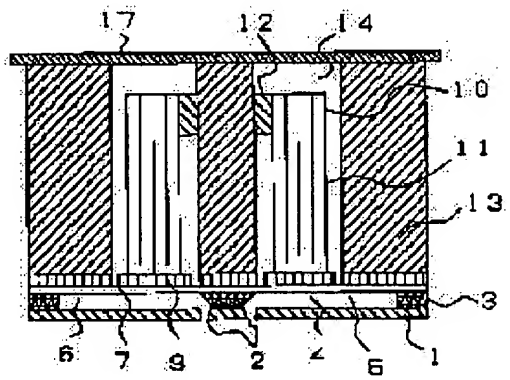
(22)Date of filing : **10.09.1997**

(71)Applicant : **SEIKO EPSON CORP**
(72)Inventor : **KAYANO YUJI**
KARASAWA YASUSHI
ARAKAWA KATSUHARU

(54) INK-JET HEAD AND PRODUCTION METHOD THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an ink-jet head with high size accuracy and positioning accuracy, and a production method thereof.
SOLUTION: A highly oriented film to be a vibrating plate 7 is adhered on a spacer 3. An island part 9 is formed thereon with a photosensitive resin film. The island part 9 elongates in the longitudinal direction of a pressure generating room 4 for efficiently transmitting dislocation of a piezoelectric oscillator 11. By accordingly forming the island part 9 of a photosensitive resin film integrally with the spacer 3 and the vibrating plate 7, an ink-jet head with little printing quality irregularity can be produced with a high yield.



LEGAL STATUS

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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The ink-jet head characterized by the aforementioned island section being a photopolymer in the ink-jet head which consists of the nozzle plate which the nozzle was able to open, the spacer which forms a pressure occurrence room, an ink supply way, and a common ink room, a passage unit formed from the diaphragm equipped with the island section which is joined to a spacer and counters the aforementioned pressure occurrence room, and a piezoelectric transducer in the longitudinal-oscillation mode which makes an ink drop breathe out in contact with the aforementioned island section.
[Claim 2] In the manufacture technique of manufacturing an ink-jet head according to claim 1 (a) The process which joins a macromolecule oriented film to the spacer with which the pressure occurrence room, the ink supply way, and the common ink room were formed with adhesives, (b) The process which forms the photopolymer layer which forms the island section on the aforementioned macromolecule oriented film, (c) The process which exposes the aforementioned photopolymer layer and prints the pattern of the aforementioned island section, (d) The process which develops the exposed aforementioned photopolymer layer and forms the aforementioned island section, (e) The manufacture technique of the ink-jet head characterized by including the process which stiffens the aforementioned island section by one or more processings among heat-treatment, UV-irradiation processing, or electron-beam-irradiation processing.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the structure and its manufacture technique of the ink-jet head which makes the piezoelectric transducer in the longitudinal-oscillation mode a driving source.
[0002]
[Description of the Prior Art] The pitch between nozzles is in a reduction inclination, and carry out anisotropic etching of the silicon-single-crystal wafer, fix with adhesives the nozzle plate and diaphragm which were produced by this by other technique, and constitute a passage unit, in order to raise the recording density of an ink-jet head, transmit the variation rate of a piezoelectric transducer to this, and a pressure occurrence room is made to generate a pressure, and it is constituted so that an ink drop may be made to breathe out from a nozzle with this pressure.
[0003] Thus, since the width of face of a pressure occurrence room will become very small if the array density of a pressure occurrence room becomes large, it will be necessary to make the whole longitudinal direction of a pressure occurrence room transform efficiently. Therefore, a heights long to the longitudinal direction of a pressure occurrence room and the so-called island section are formed on a diaphragm, and the variation rate of a piezoelectric transducer is transmitted to the diaphragm through this island section.
[0004] The technique by electroplating of the nickel with which the technique of forming this island section is indicated by the example of JP,6-143573,A, and the technique of etching the metal sheet metal currently indicated by the example of JP,8-187868,A are proposed.
[0005]
[Problem(s) to be Solved by the Invention] However, there was a technical probrem which is listed to a degree in a proior art. By the technique of forming the island section by electroplating of the nickel of JP,6-143573,A first, the technical probrem that it was very difficult to manage the height of the island section occurred. If the heights of the island section differ for every pressure occurrence room, since the amounts of diaphragm deflections after an ink-jet head assembly will differ for every pressure occurrence room and every head and dispersion will arise in an ink regurgitation property, a quality of printed character deteriorates.
[0006] Moreover, since etching was not stabilized by the technique of forming the island section by etching in the metal thin film of JP,8-187868,A, the technical probrem that the yield was very low occurred.
[0007] Moreover, when it was common in both of the above-mentioned technique and the diaphragm and spacer after island formation were joined, the technical probrem that position doubling was difficult occurred. Although less than **10-micron position ****** was demanded for securing a quality of printed character, when priority is given to precision and position doubling is carried out, working efficiency falls, and when priority is given to working efficiency, position doubling precision becomes a fall, as a result the cause by which the ink regurgitation property for every head varies.
[0008] this invention solves these technical probrems and the purpose is offering the ink-jet head with high dimensional accuracy and position doubling precision, and its manufacture technique.
[0009]
[Means for Solving the Problem] The ink-jet head of this invention consists of the nozzle plate which the nozzle was able to open, a spacer which forms a pressure occurrence room, an ink supply way, and a common ink room, a passage unit formed from the diaphragm equipped with the island section which is joined to a spacer and counters the aforementioned pressure occurrence room, and a piezoelectric transducer in the longitudinal-oscillation mode which makes an ink drop breathe out in contact with the aforementioned island section, and it is characterized by forming the aforementioned island section by the photopolymer.
[0010] Moreover, the manufacture technique of the ink-jet head of this invention (a) The process which joins a macromolecule oriented film to the spacer with which the pressure occurrence room, the ink supply way, and the common ink room were formed with adhesives, (b) The process which forms the photopolymer layer which forms the island section on the aforementioned macromolecule oriented film, (c) The process which exposes the aforementioned photopolymer layer and prints the pattern of the aforementioned island section, (d) It is characterized by including the process which develops the exposed aforementioned photopolymer layer and forms the aforementioned island section, and the process which stiffens the aforementioned island section by one or more processings among (e) heat-treatment, UV-irradiation processing, or electron-beam-irradiation processing.
[0011]

[Embodiments of the Invention] Below, it explains based on the example illustrating the detail of this invention. Drawing 1 is an assembly perspective diagram of this invention, and drawing 2 is a cross section of the ink-jet head of this invention. The passage unit is constituted by the spacer 3 which divides the nozzle plate 1 and the pressure occurrence room 4 in which many nozzles 2 were formed, the ink supply way 5, and the reservoir 6, and the diaphragm 7 in which the island section 9 was formed. The spacer 3 and the diaphragm 7 in which the island section 9 was formed are formed by one so that it may mention later.
[0012] A macromolecule oriented film is used for a diaphragm 7, and the island section 9 is formed in the front face by forming and hardening [expose, develop and] a photopolymer layer. This island section 9 is formed in the central field of the cross direction of the pressure occurrence room 4 for a long time at the longitudinal direction of the pressure occurrence room 4, and a diaphragm 7 receives the variation rate by the piezoelectric transducer 11 mentioned later through this island section 9.
[0013] the vibrator unit hold to which the vibrator unit 10 constituted by fixing to a stationary plate 12 two or more piezoelectric transducers 11 which have the longitudinal-oscillation mode was formed in the pedestal 13 -- it holds in a hole 14, it is positioned so that the island section 9 of a diaphragm 7 may be contacted in a nose of cam, and it is fixed to the pedestal 13 through the stationary plate 12
[0014] The ink supply pipe 15 linked to an ink tank is formed in the pedestal 13, and the common reservoir 6 constituted by the spacer 3 through the ink feed hopper 8 of a diaphragm 7 in the nose of cam is open for free passage. In addition, the passage unit constituted by a nozzle plate 1, the spacer 3, and the diaphragm 7 is fixed to a pedestal 13 with a frame 16, and a head is fixed to carriage through a substrate 17.
[0015] Next, the manufacture technique which forms the spacer 3 and the diaphragm 7 which were mentioned above, and the island section 9 by one is explained according to drawing 3 . Although only one spacer is displayed drawing, this process is performed in a wafer process like a semiconductor manufacturing process, and many spacers 3 are formed in the silicon substrate of one sheet. When only calling it a spacer 3 by the following explanations, the thing of the wafer status is put.
[0016] (Example) In this example, the spacer 3 with which the pressure occurrence room 4, the ink feed hopper 5, the reservoir 6, etc. were formed first is formed by the alkali anisotropic etching of a silicon single crystal (a).
[0017] The field by the side of the diaphragm of this spacer 3 is coated with adhesives, a macromolecule oriented film, for example, the oriented film of polyphenylene sulfide resin (PPS), is pasted up, and it considers as a diaphragm 7 (b). Next, the photopolymer film 71 is formed on a diaphragm 7 (c). Ultraviolet rays are irradiated through the photo-mask pattern of the island section 9 which made position doubling this photopolymer film 71, and the pattern 72 of the island section 9 is printed (d). The pattern of the fractions which need to leave a photopolymer film in addition to island section 9, such as a fraction to which a pedestal 13 is joined at this time, is also printed simultaneously.
[0018] After developing this photopolymer film 71 and forming the island section 9, the island section 9 is stiffened (e). At this time, the island section was stiffened on condition that Table 1, and the sample 1 and the sample 2 were produced.
[0019]
[Table 1]

	硬化条件
試料１	１５０℃のホットプレート上で加熱しながら、１ｋＷのＵＶランプを用いて紫外線を１０分以上照射処理する。
試料２	１５０ｋＶの加速電圧で５０ｋＧｙ以上の電子線を照射した後、１５０℃のオーブンで３０分以上加熱処理する。

[0020] Then, the ink feed hopper 8 is formed in the diaphragm 7 of the reservoir 6 section by suitable technique, such as laser and a press, (f).
[0021] It is possible to form a spacer 3, the diaphragm 7, and the island section 9 by one by such manufacture technique. Then, a spacer 3 is cut for each head of every after pasting up a nozzle plate 1 on a spacer 3, and an ink-jet head is assembled.
[0022] (Example 1 of a comparison) For the comparison, by electroplating of nickel, the island section was formed on the diaphragm and the ink-jet head was assembled. On the diaphragm in which the metal thin film with a thickness of 5000A or less was formed, the pattern of the island section is formed by the resist and the island section is formed by electroplating of nickel. After removing the resist of a plating mask, a nozzle plate, a spacer, and a diaphragm are pasted up, a spacer is cut for each head of every, and an ink-jet head is assembled.
[0023] (Example 2 of a comparison) Again, for the comparison, by etching of metal sheet metal, the island section was formed on the diaphragm and the ink-jet head was assembled. On the sheet metal with a thickness [which was pasted up with the diaphragm] of 30 microns of SUS, the pattern of the island section is formed by the resist, and the island section is formed by etching by the ferric oxide aqueous solution. After removing the resist of an etching mask, a nozzle plate, a spacer, and a diaphragm are pasted up, a spacer is cut for each head of every, and an ink-jet head is assembled.
[0024] Thus, the percent defective at the time of conducting a printing check after height dispersion of the island section of the manufactured ink-jet head, a dimensional accuracy, the position gap precision of a spacer and the island section, and ink-jet head assembly is shown in Table 2.
[0025]
[Table 2]

	実施例 試料1	実施例 試料2	比較例1	比較例2
アイランド部 高さばらつき 単位：ミクロン	±0．9	±0．9	±2．7	±0．4
アイランド部 寸法精度 単位:ミクロン	±2．8	±2．8	±3．2	±12．3
位置ずれ精度 単位：ミクロン	±2．3	±2．3	±8．4	±8．4
印字検査 不良率 単位：%	0．7	0．7	6．4	7．3

[0026] Consequently, the percent defective of island section height dispersion, a dimensional accuracy, the position gap precision of a spacer and the island section, and a printing check is greatly improved by this invention.
[0027] Thus, since the island section 9 is formed with the photopolymer film, compared with the case where it forms by electroplating metallurgy group etching, a dimensional accuracy can be made very high. Moreover, since a positioning of a spacer 3 and the island section 9 can carry out in the position doubling precision of a ********** process, it can make a position gap very small compared with a conventional method.
[0028] In addition, in the above-mentioned example, although the spacer formed of silicon anisotropic etching is used, if a precision prescribe is filled, the spacer produced by other quality of the materials, such as injection molding of plastics, metaled press working of sheet metal, and plating of a metal, and the process is also usable.
[0029] Moreover, although the polyphenylene sulfide (PPS) resin is used as a macromolecule oriented film in the above-mentioned example Other polymeric materials which can be extended, for example, a polyimide (PI) resin, a polyether imide (PEI) resin, A boria ********** (PAI) resin, a poly-rose van acid (PPA) resin, A poly-ape phone (PSF) resin, a polyether sulphone (PES) resin, A polyether ketone (PEK) resin, a polyether ether ketone (PEEK) resin, A polyolefine (APO) resin, a polyethylenenaphthalate (PEN) resin, an aramid resin, polypropylene resin, a vinylidene chloride resin, polycarbonate resin, etc. can also be used.
[0030] Moreover, although the film-like thing is used as a photopolymer which forms the island section, as long as conditions, such as a dimensional accuracy, suit, the spin coat of a liquefied photosensitive polyimide, the photoresist, etc. may be carried out, and they may be used.
[0031]
[Effect of the Invention] The nozzle plate in which the nozzle was opened by this invention as explained above, The spacer which forms a pressure occurrence room, an ink supply way, and a common ink room, The passage unit formed from the diaphragm equipped with the island section which is joined to a spacer and counters the aforementioned pressure occurrence room, In order to form the island section by the photopolymer in the ink-jet head which consists of a piezoelectric transducer in the longitudinal-oscillation mode which makes an ink drop breathe out in contact with the aforementioned island section, A dimensional accuracy and the positioning accuracy with a spacer are very high, and an ink-jet head can be manufactured by the high yield.
[0032] Furthermore, since the positioning accuracy of the island section and a spacer is high, ink regurgitation property dispersion for every head can be reduced, and a quality of printed character can be stabilized.

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TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to the structure and its manufacture technique of the ink-jet head which makes the piezoelectric transducer in the longitudinal-oscillation mode a driving source.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] The pitch between nozzles is in a reduction inclination, and carry out anisotropic etching of the silicon-single-crystal wafer, fix with adhesives the nozzle plate and diaphragm which were produced by this by other technique, and constitute a passage unit, in order to raise the recording density of an ink-jet head, transmit the variation rate of a piezoelectric transducer to this, and a pressure occurrence room is made to generate a pressure, and it is constituted so that an ink drop may be made to breathe out from a nozzle with this pressure.

[0003] Thus, since the width of face of a pressure occurrence room will become very small if the array density of a pressure occurrence room becomes large, it will be necessary to make the whole longitudinal direction of a pressure occurrence room transform efficiently. Therefore, a heights long to the longitudinal direction of a pressure occurrence room and the so-called island section are formed on a diaphragm, and the variation rate of a piezoelectric transducer is transmitted to the diaphragm through this island section.

[0004] The technique by electroplating of the nickel with which the technique of forming this island section is indicated by the example of JP,6-143573,A, and the technique of etching the metal sheet metal currently indicated by the example of JP,8-187868,A are proposed.

[Translation done.]

* NOTICES *

EFFECT OF THE INVENTION

[Effect of the Invention] The nozzle plate in which the nozzle was opened by this invention as explained above, The spacer which forms a pressure occurrence room, an ink supply way, and a common ink room, The passage unit formed from the diaphragm equipped with the island section which is joined to a spacer and counters the aforementioned pressure occurrence room, In order to form the island section by the photopolymer in the ink-jet head which consists of a piezoelectric transducer in the longitudinal-oscillation mode which makes an ink drop breathe out in contact with the aforementioned island section, A dimensional accuracy and the positioning accuracy with a spacer are very high, and an ink-jet head can be manufactured by the high yield.
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TECHNICAL PROBLEM

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[0006] Moreover, since etching was not stabilized by the technique of forming the island section by etching in the metal thin film of JP,8-187868,A, the technical probrem that the yield was very low occurred.
[0007] Moreover, when it was common in both of the above-mentioned technique and the diaphragm and spacer after island formation were joined, the technical probrem that position doubling was difficult occurred. Although less than **10-micron position ****** was demanded for securing a quality of printed character, when priority is given to precision and position doubling is carried out, working efficiency falls, and when priority is given to working efficiency, position doubling precision becomes a fall, as a result the cause by which the ink regurgitation property for every head varies.
[0008] this invention solves these technical probrems and the purpose is offering the ink-jet head with high dimensional accuracy and position doubling precision, and its manufacture technique.

[Translation done.]

MEANS

[Means for Solving the Problem] The ink-jet head of this invention consists of the nozzle plate which the nozzle was able to open, a spacer which forms a pressure occurrence room, an ink supply way, and a common ink room, a passage unit formed from the diaphragm equipped with the island section which is joined to a spacer and counters the aforementioned pressure occurrence room, and a piezoelectric transducer in the longitudinal-oscillation mode which makes an ink drop breathe out in contact with the aforementioned island section, and it is characterized by forming the aforementioned island section by the photopolymer.
[0010] Moreover, the manufacture technique of the ink-jet head of this invention (a) The process which joins a macromolecule oriented film to the spacer with which the pressure occurrence room, the ink supply way, and the common ink room were formed with adhesives, (b) The process which forms the photopolymer layer which forms the island section on the aforementioned macromolecule oriented film, (c) The process which exposes the aforementioned photopolymer layer and prints the pattern of the aforementioned island section, (d) It is characterized by including the process which develops the exposed aforementioned photopolymer layer and forms the aforementioned island section, and the process which stiffens the aforementioned island section by one or more processings among (e) heat-treatment, UV-irradiation processing, or electron-beam-irradiation processing.
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[0013] the vibrator unit hold to which the vibrator unit 10 constituted by fixing to a stationary plate 12 two or more piezoelectric transducers 11 which have the longitudinal-oscillation mode was formed in the pedestal 13 -- it holds in a hole 14, it is positioned so that the island section 9 of a diaphragm 7 may be contacted in a nose of cam, and it is fixed to the pedestal 13 through the stationary plate 12
[0014] The ink supply pipe 15 linked to an ink tank is formed in the pedestal 13, and the common reservoir 6 constituted by the spacer 3 through the ink feed hopper 8 of a diaphragm 7 in the nose of cam is open for free passage. In addition, the passage unit constituted by a nozzle plate 1, the spacer 3, and the diaphragm 7 is fixed to a pedestal 13 with a frame 16, and a head is fixed to carriage through a substrate 17.
[0015] Next, the manufacture technique which forms the spacer 3 and the diaphragm 7 which were mentioned above, and the island section 9 by one is explained according to drawing 3 . Although only one spacer is displayed drawing, this process is performed in a wafer process like a semiconductor manufacturing process, and many spacers 3 are formed in the silicon substrate of one sheet. When only calling it a spacer 3 by the following explanations, the thing of the wafer status is put.

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EXAMPLE

(Example) In this example, the spacer 3 with which the pressure occurrence room 4, the ink feed hopper 5, the reservoir 6, etc. were formed first is formed by the alkali anisotropic etching of a silicon single crystal (a).
[0017] The field by the side of the diaphragm of this spacer 3 is coated with adhesives, a macromolecule oriented film, for example, the oriented film of polyphenylene sulfide resin (PPS), is pasted up, and it considers as a diaphragm 7 (b). Next, the photopolymer film 71 is formed on a diaphragm 7 (c). Ultraviolet rays are irradiated through the photo-mask pattern of the island section 9 which made position doubling this photopolymer film 71, and the pattern 72 of the island section 9 is printed (d). The pattern of the fractions which need to leave a photopolymer film in addition to island section 9, such as a fraction to which a pedestal 13 is joined at this time, is also printed simultaneously.
[0018] After developing this photopolymer film 71 and forming the island section 9, the island section 9 is stiffened (e). At this time, the island section was stiffened on condition that Table 1, and the sample 1 and the sample 2 were produced.
[0019]
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試料２	１５０kＶの加速電圧で５０kＧｙ以上の電子線を照射した後、１５０℃のオーブンで３０分以上加熱処理する。

[0020] Then, the ink feed hopper 8 is formed in the diaphragm 7 of the reservoir 6 section by suitable technique, such as laser and a press, (f).
[0021] It is possible to form a spacer 3, the diaphragm 7, and the island section 9 by one by such manufacture technique. Then, a spacer 3 is cut for each head of every after pasting up a nozzle plate 1 on a spacer 3, and an ink-jet head is assembled.
[0022] (Example 1 of a comparison) For the comparison, by electroplating of nickel, the island section was formed on the diaphragm and the ink-jet head was assembled. On the diaphragm in which the metal thin film with a thickness of 5000A or less was formed, the pattern of the island section is formed by the resist and the island section is formed by electroplating of nickel. After removing the resist of a plating mask, a nozzle plate, a spacer, and a diaphragm are pasted up, a spacer is cut for each head of every, and an ink-jet head is assembled.
[0023] (Example 2 of a comparison) Again, for the comparison, by etching of metal sheet metal, the island section was formed on the diaphragm and the ink-jet head was assembled. On the sheet metal with a thickness [which was pasted up with the diaphragm] of 30 microns of SUS, the pattern of the island section is formed by the resist, and the island section is formed by etching by the ferric oxide aqueous solution. After removing the resist of an etching mask, a nozzle plate, a spacer, and a diaphragm are pasted up, a spacer is cut for each head of every, and an ink-jet head is assembled.
[0024] Thus, the percent defective at the time of conducting a printing check after height dispersion of the island section of the manufactured ink-jet head, a dimensional accuracy, the position gap precision of a spacer and the island section, and ink-jet head assembly is shown in Table 2.
[0025]
[Table 2]

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[0026] Consequently, the percent defective of island section height dispersion, a dimensional accuracy, the position gap precision of a spacer and the island section, and a printing check is greatly improved by this invention.
[0027] Thus, since the island section 9 is formed with the photopolymer film, compared with the case where it forms by electroplating metallurgy group etching, a dimensional accuracy can be made very high. Moreover, since a positioning of a spacer 3 and the island section 9 can carry out in the position doubling precision of a ********** process, it can make a position gap very small compared with a conventional method.
[0028] In addition, in the above-mentioned example, although the spacer formed of silicon anisotropic etching is used, if a precision prescribe is filled, the spacer produced by other quality of the materials, such as injection molding of plastics, metaled press working of sheet metal, and plating of a metal, and the process is also usable.
[0029] Moreover, although the polyphenylene sulfide (PPS) resin is used as a macromolecule oriented film in the above-mentioned example Other polymeric materials which can be extended, for example, a polyimide (PI) resin, a polyether imide (PEI) resin, A boria ********** (PAI) resin, a poly-rose van acid (PPA) resin, A poly-ape phone (PSF) resin, a polyether sulphone (PES) resin, A polyether ketone (PEK) resin, a polyether ether ketone (PEEK) resin, A polyolefine (APO) resin, a polyethylenenaphthalate (PEN) resin, an aramid resin, polypropylene resin, a vinylidene chloride resin, polycarbonate resin, etc. can also be used.
[0030] Moreover, although the film-like thing is used as a photopolymer which forms the island section, as long as conditions, such as a dimensional accuracy, suit, the spin coat of a liquefied photosensitive polyimide, the photoresist, etc. may be carried out, and they may be used.

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

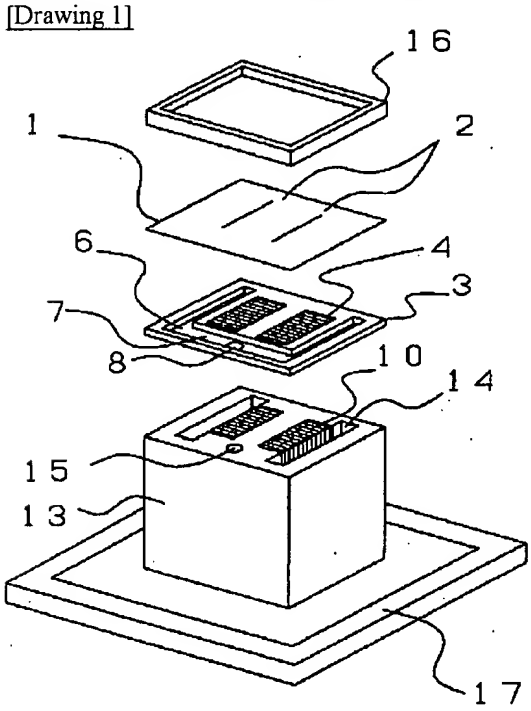
[Brief Description of the Drawings]
[Drawing 1] The assembly perspective diagram of the ink-jet head of this invention.
[Drawing 2] The cross section of the ink-jet head of this invention.
[Drawing 3] The cross section of the manufacture technique which forms the spacer, the diaphragm, and the island section of an ink-jet head of this invention by one.
[Description of Notations]
1 Nozzle Plate
2 Nozzle
3 Spacer
4 Pressure Occurrence Room
5 Ink Supply Way
6 Reservoir
7 Diaphragm
8 Ink Feed Hopper
9 Island Section
10 Vibrator Unit
11 Piezoelectric Transducer
12 Stationary Plate
13 Pedestal
14 vibrator unit hold -- a hole
15 Ink Supply Pipe
16 Passage Unit Fixed Frame
17 Substrate
71 Photopolymer Film
72 Pattern of Island Section

[Translation done.]

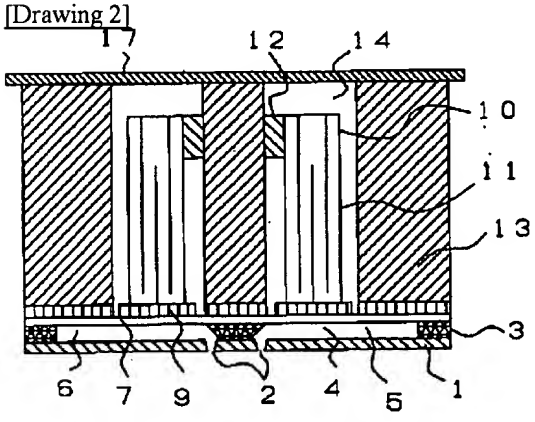
* NOTICES *

DRAWINGS

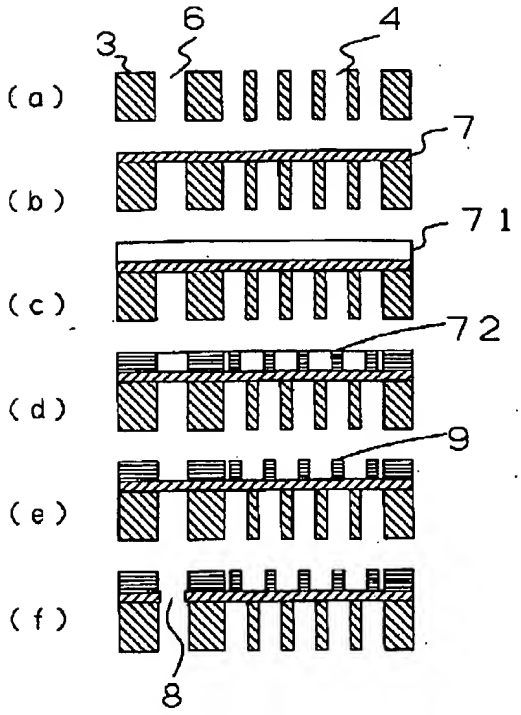
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]

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(71)出願人　000002369
セイコーエプソン株式会社
東京都新宿区西新宿２丁目４番１号

(72)発明者　茅野　祐治
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

(72)発明者　柄沢　康史
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

(72)発明者　荒川　克治
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内

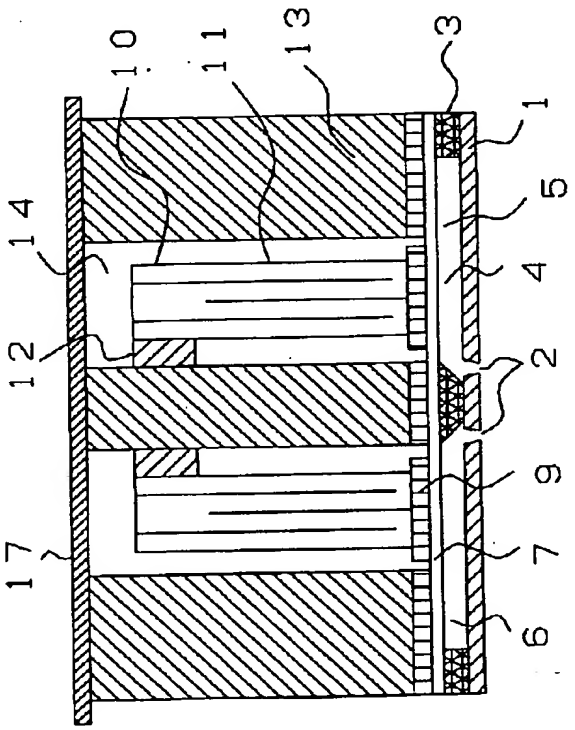
(74)代理人　弁理士　鈴木　喜三郎　（外２名）

(54)【発明の名称】　インクジェットヘッドおよびその製造方法

(57)【要約】

【課題】　従来技術では、振動板上に形成されたアイランド部の寸法精度、位置合わせ精度が低く、製造プロセスの歩留まりが低く、印字品質のばらつきが発生してしまう。

【解決手段】　スペーサー３に振動板７となる高延伸フィルムが接着され、その上に感光性樹脂フィルムでアイランド部９を形成する。このアイランド部９は圧力発生室４の長手方向に伸びており、圧電振動子１１の変位を効率よく振動板７に伝達する。このようにアイランド部９を感光性樹脂フィルムによってスペーサー３、振動板７と一体で形成することにより、印字品質のばらつきが少ないインクジェットヘッドを高歩留まりで製造することができる。



【特許請求の範囲】
【請求項１】　ノズルが開けられたノズルプレートと、圧力発生室およびインク供給路および共通のインク室を形成するスペーサーと、スペーサーに接合され前記圧力発生室に対向するアイランド部を備えた振動板から形成される流路ユニットと、前記アイランド部に当接してインク滴を吐出させる縦振動モードの圧電振動子とからなるインクジェットヘッドにおいて、前記アイランド部が感光性樹脂であることを特徴とするインクジェットヘッド。
【請求項２】　請求項１記載のインクジェットヘッドを製造する製造方法において、（ａ）圧力発生室およびインク供給路および共通のインク室が形成されたスペーサーに高分子延伸フィルムを接着剤により接合する工程と、（ｂ）前記高分子延伸フィルム上にアイランド部を形成する感光性樹脂層を形成する工程と、（ｃ）前記感光性樹脂層を露光して前記アイランド部のパターンを焼き付ける工程と、（ｄ）露光した前記感光性樹脂層を現像して前記アイランド部を形成する工程と、（ｅ）加熱処理または紫外線照射処理または電子線照射処理のうち、１以上の処理によって前記アイランド部を硬化させる工程を含むことを特徴とするインクジェットヘッドの製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、縦振動モードの圧電振動子を駆動源とするインクジェットヘッドの構造とその製造方法に関する。
【０００２】
【従来の技術】インクジェットヘッドの記録密度を向上させるためにノズル間ピッチは縮小傾向にあり、シリコン単結晶ウェハーを異方性エッチングし、これに他の方法で作製されたノズルプレートや振動板を接着剤で固定して流路ユニットを構成し、これに圧電振動子の変位を伝達して圧力発生室に圧力を発生させ、この圧力によってインク滴をノズルから吐出させるように構成されている。
【０００３】このように圧力発生室の配列密度が大きくなると圧力発生室の幅が極めて小さくなるため、圧力発生室の長手方向全体を効率的に変形させる必要が生じる。そのため振動板上に圧力発生室の長手方向に長い凸部、いわゆるアイランド部を形成し、このアイランド部を介して圧電振動子の変位を振動板に伝達している。
【０００４】このアイランド部を形成する方法は、特開平６－１４３５７３の実施例に開示されているニッケルの電気メッキによる方法や、特開平８－１８７８６８の実施例に開示されている金属薄板をエッチングする方法が提案されている。
【０００５】
【発明が解決しようとする課題】しかし、従来の技術には次に挙げるような課題があった。まず特開平６－１４３５７３のニッケルの電気メッキによってアイランド部を形成する方法では、アイランド部の高さを管理するのが非常に難しいという課題があった。アイランド部の高さが圧力発生室ごとに異なると、インクジェットヘッド組み立て後の振動板たわみ量が圧力発生室ごとまたはヘッドごとに異なり、インク吐出特性にばらつきが生じるため、印字品質が低下する。
【０００６】また特開平８－１８７８６８の金属薄膜をエッチングによってアイランド部を形成する方法では、エッチングが安定しないため歩留まりが非常に低いという課題があった。
【０００７】また、前述のどちらの方法にも共通して、アイランド形成後の振動板とスペーサーを接合する場合に、位置合わせが難しいという課題があった。印字品質を確保するには±１０ミクロン以内での位置あわせが要求されるが、精度を優先させて位置合わせした場合は作業効率が低下し、作業効率を優先させた場合は位置合わせ精度が低下、ひいてはヘッドごとのインク吐出特性がばらつく原因となる。
【０００８】本発明はこれらの課題を解決するものであり、その目的は寸法精度、位置合わせ精度が高いインクジェットヘッドおよびその製造方法を提供することである。
【０００９】
【課題を解決するための手段】本発明のインクジェットヘッドは、ノズルが開けられたノズルプレートと、圧力発生室およびインク供給路および共通のインク室を形成するスペーサーと、スペーサーに接合され前記圧力発生室に対向するアイランド部を備えた振動板から形成される流路ユニットと、前記アイランド部に当接してインク滴を吐出させる縦振動モードの圧電振動子とから構成され、前記アイランド部が感光性樹脂で形成されることを特徴とする。
【００１０】また本発明のインクジェットヘッドの製造方法は、（ａ）圧力発生室およびインク供給路および共通のインク室が形成されたスペーサーに高分子延伸フィルムを接着剤により接合する工程と、（ｂ）前記高分子延伸フィルム上にアイランド部を形成する感光性樹脂層を形成する工程と、（ｃ）前記感光性樹脂層を露光して前記アイランド部のパターンを焼き付ける工程と、（ｄ）露光した前記感光性樹脂層を現像して前記アイランド部を形成する工程と、（ｅ）加熱処理または紫外線照射処理または電子線照射処理のうち、１以上の処理によって前記アイランド部を硬化させる工程を含むことを特徴とする。
【００１１】
【発明の実施の形態】以下に、本発明の詳細を図示した実施例に基づいて説明する。図１は本発明の組立斜視図、図２は本発明のインクジェットヘッドの断面図であ

る。ノズル２が多数設けられたノズルプレート１、圧力発生室４およびインク供給路５およびリザーバー６を区画するスペーサー３、アイランド部９が形成された振動板７によって流路ユニットが構成されている。スペーサー３と、アイランド部９が形成された振動板７は後述するように一体で形成されている。

【００１２】振動板７には高分子延伸フィルムを使用し、その表面には感光性樹脂層を形成し露光、現像、硬化することでアイランド部９が形成されている。このアイランド部９は、圧力発生室４の幅方向の中心領域に、圧力発生室４の長手方向に長く形成されており、振動板７はこのアイランド部９を介して、後述する圧電振動子１１による変位を受けるようになっている。

【００１３】縦振動モードを有する複数の圧電振動子１１を固定板１２に固定して構成された振動子ユニット１０は、基台１３に形成された振動子ユニット収容孔１４に収容され、先端を振動板７のアイランド部９に当接するように位置決めされて固定板１２を介して基台１３に固定されている。

【００１４】基台１３には、インクタンクに接続するインク供給管１５が設けられており、その先端を振動板７のインク供給口８を介してスペーサ３により構成された共通のリザーバー６に連通されている。なおノズルプレート１、スペーサ３、及び振動板７により構成される流路ユニットは、枠体１６によって基台１３に固定され、ヘッドは基板１７を介してキャリッジに固定される。

【００１５】次に、上述したスペーサー３と振動板７とアイランド部９を一体で形成する製造方法を図３に従って説明する。図では一つのスペーサーしか表示していないが、この工程は半導体製造工程のようなウェハープロセスで行われ、１枚のシリコン基板に多数のスペーサー３が形成される。以下の説明で単にスペーサー３という場合は、ウェハー状態のものをさす。

【００１６】（実施例）本実施例では、まず圧力発生室４、インク供給口５、リザーバー６等が形成されたスペーサー３をシリコン単結晶のアルカリ異方性エッチングによって形成する（ａ）。

【００１７】このスペーサー３の振動板側の面に接着剤をコーティングし、高分子延伸フィルム、例えばポリフェニレンサルファイド樹脂（ＰＰＳ）の延伸フィルムを接着し振動板７とする（ｂ）。次に振動板７上に感光性樹脂フィルム７１を形成する（ｃ）。この感光性樹脂フィルム７１に位置合わせをしたアイランド部９のフォトマスクパターンを通して紫外線を照射し、アイランド部９のパターン７２を焼き付ける（ｄ）。この時基台１３が接合される部分など、アイランド部９以外に感光性樹脂フィルムを残す必要がある部分のパターンも同時に焼き付けられる。

【００１８】この感光性樹脂フィルム７１を現像してアイランド部９を形成した後、アイランド部9を硬化させる（ｅ）。この時、表１の条件でアイランド部を硬化させ、試料１、試料２を作製した。

【００１９】

【表１】

	硬化条件
試料１	１５０℃のホットプレート上で加熱しながら、１ｋＷのＵＶランプを用いて紫外線を１０分以上照射処理する。
試料２	１５０ｋＶの加速電圧で５０ｋＧｙ以上の電子線を照射した後、１５０℃のオーブンで３０分以上加熱処理する。

【００２０】その後、レーザー、プレスなど適切な方法で、リザーバー６部の振動板７にインク供給口８を形成する（ｆ）。

【００２１】これらの製造方法によって、スペーサー３と振動板７とアイランド部９を一体で形成することが可能である。この後、スペーサー３にノズルプレート１を接着後、スペーサー３を一つ一つのヘッドごとに切断し、インクジェットヘッドを組み立てる。

【００２２】（比較例１）比較のため、ニッケルの電気めっきによって振動板上にアイランド部を形成し、インクジェットヘッドを組み立てた。厚み５０００オングストローム以下の金属薄膜を形成した振動板上に、レジストでアイランド部のパターンを形成し、ニッケルの電気めっきによってアイランド部を形成する。メッキマスクのレジストを除去した後、ノズルプレート、スペーサー、振動板を接着し、スペーサーを一つ一つのヘッドごとに切断し、インクジェットヘッドを組み立てる。

【００２３】（比較例２）また比較のため、金属薄板のエッチングによって振動板上にアイランド部を形成し、インクジェットヘッドを組み立てた。振動板と接着した厚さ３０ミクロンのＳＵＳの薄板上に、レジストでアイランド部のパターンを形成し、酸化第二鉄水溶液によるエッチングによってアイランド部を形成する。エッチングマスクのレジストを除去した後、ノズルプレート、スペーサー、振動板を接着し、スペーサーを一つ一つのヘッドごとに切断し、インクジェットヘッドを組み立てる。

【００２４】このようにして製造されたインクジェットヘッドの、アイランド部の高さばらつきと寸法精度、スペーサーとアイランド部の位置ずれ精度、インクジェットヘッド組立後に印字検査を行った場合の不良率を表２に示す。

【００２５】

【表２】

	実施例 試料１	実施例 試料２	比較例１	比較例２
アイランド部 高さばらつき 単位：ミクロン	±０．９	±０．９	±２．７	±０．４
アイランド部 寸法精度 単位:ミクロン	±２．８	±２．８	±３．２	±１２．３
位置ずれ精度 単位：ミクロン	±２．３	±２．３	±８．４	±８．４
印字検査 不良率 単位：％	０．７	０．７	６．４	７．３

【００２６】その結果、アイランド部高さばらつき、寸法精度、スペーサーとアイランド部の位置ずれ精度、印字検査の不良率とも本発明によって大きく改善されている。

【００２７】このようにアイランド部９が感光性樹脂フィルムで形成されているため、電気めっきや金属エッチングによって形成する場合に比べて寸法精度を非常に高くすることができる。またスペーサー３とアイランド部９の位置決めが、フォトリソ工程の位置合わせ精度で実施できるため、従来法に比べて位置ずれを極めて小さくすることができる。

【００２８】なお上述の実施例においては、シリコン異方性エッチングによって形成されたスペーサーを使用しているが、要求精度を満たすものであればプラスチックの射出成形、金属のプレス加工、金属のメッキなど他の材質、製法で作製されたスペーサーも使用可能である。

【００２９】また上述の実施例では高分子延伸フィルムとしてポリフェニレンサルフアイド（ＰＰＳ）樹脂を用いているが、延伸可能な他の高分子材料、例えば、ポリイミド（ＰＩ）樹脂、ポリエーテルイミド（ＰＥＩ）樹脂、ボリアミドイミド（ＰＡＩ）樹脂、ポリバラバン酸（ＰＰＡ）樹脂、ポリサルホン（ＰＳＦ）樹脂、ポリエーテルサルホン（ＰＥＳ）樹脂、ポリエーテルケトン（ＰＥＫ）樹脂、ポリエーテルエーテルケトン（ＰＥＥＫ）樹脂、ポリオレフィン（ＡＰＯ）樹脂、ポリエチレンナフタレート（ＰＥＮ）樹脂、アラミド樹脂、ポリプロピレン樹脂、塩化ビニリデン樹脂、ポリカーボネート樹脂等を用いることもできる。

【００３０】またアイランド部を形成する感光性樹脂としてフィルム状のものを用いているが、寸法精度などの条件が適合すれば、液状の感光性ポリイミド、フォトレジストなどをスピンコートして利用してもよい。

【００３１】

【発明の効果】以上説明したように本発明によって、ノズルが開けられたノズルプレートと、圧力発生室およびインク供給路および共通のインク室を形成するスペーサーと、スペーサーに接合され前記圧力発生室に対向するアイランド部を備えた振動板から形成される流路ユニットと、前記アイランド部に当接してインク滴を吐出させる縦振動モードの圧電振動子とからなるインクジェットヘッドにおいて、アイランド部を感光性樹脂で形成するため、寸法精度、スペーサーとの位置決め精度が非常に高く、高歩留まりでインクジェットヘッドを製造することができる。

【００３２】さらに、アイランド部とスペーサーの位置決め精度が高いので、ヘッドごとのインク吐出特性ばらつきを低減でき、印字品質を安定させることができる。

【図面の簡単な説明】

【図１】　本発明のインクジェットヘッドの組み立て斜視図。

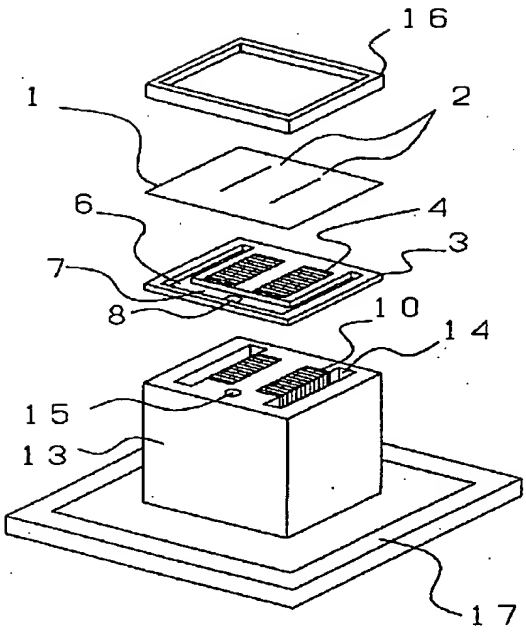
【図２】　本発明のインクジェットヘッドの断面図。

【図３】　本発明のインクジェットヘッドのスペーサーと振動板とアイランド部を一体で形成する製造方法の断面図。

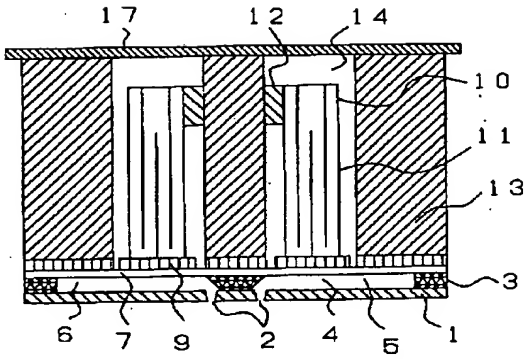
【符号の説明】

１　ノズルプレート
２　ノズル
３　スペーサー
４　圧力発生室
５　インク供給路
６　リザーバー
７　振動板
８　インク供給口
９　アイランド部
１０　振動子ユニット
１１　圧電振動子
１２　固定板
１３　基台
１４　振動子ユニット収容孔
１５　インク供給管
１６　流路ユニット固定枠
１７　基板
７１　感光性樹脂フィルム
７２　アイランド部のパターン

【図1】



【図2】



【図3】